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PROCEEDINGS OF THE 32ND ANNUAL TUNA CONFERENCE

by

Doyle A. Hanan

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ADMINISTRATIVE REPORT LJ-81-29

PROCEEDINGS OF THE
32ND ANNUAL TUNA CONFERENCE

University of California Conference Center
Lake Arrowhead, CA

May 17-20, 1981

Doyle A. Hanan, Chairman
California Department of Fish and Game
c/o Southwest Fisheries Center
National Marine Fisheries Service, NOAA
P. O. Box 271
La Jolla, CA 92038

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PREFACE

The Tuna Conference is held annually at the University of California Conference Center, Lake Arrowhead, California. The conference affords an opportunity to meet and informally discuss current topics and research in tunas and tuna fisheries. The conference is sponsored by the California Department of Fish and Game, the Inter-American Tropical Tuna Commission, and the Southwest Fisheries Center of the National Marine Fisheries Service.

The 32nd Tuna Conference was held May 17-20, 1981 and attended by 76 people. Of special interest at this conference was a section on the western Pacific, as well as a panel discussion entitled, "National Zones of Influence on the Political Aspects of Tuna Fishing." The panel was moderated by Alan Ford, Southwest Regional Director for National Marine Fisheries Service. Panelists were James Joseph, Director of Investigations, Inter-American Tropical Tuna Commission; Harold Carey, Executive Director of the U. S. Tuna Foundation, and Carmen Blondin, Director of the Office of International Fisheries Affairs, National Marine Fisheries Service. Keeping with the informal nature of the conference, the panel discussion has not been recorded or summarized. Abstracts and summaries of the papers presented at the conference are included in these proceedings.

At the business meeting, Dr. Sam Herrick, SWFC, P. O. Box 271, La Jolla, California 92038, was elected chairman for the 33rd Conference to be held May 16-19, 1982 at the University of California Conference Center, Lake Arrowhead, California.

Doyle Hanan
Chairman

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NMFS TUNA RESEARCH EFFORTS IN THE CENTRAL AND WESTERN PACIFIC

Richard S. Shomura

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For the past several years the Honolulu Laboratory of the Southwest Fisheries Center has not carried out any active major ocean-field work on tunas. While data on tunas have been collected as an ancillary part of our work in the Northwestern Hawaiian Islands, the major emphasis on tuna research has been confined to collecting and analyzing fishery-generated data and carrying out shoreside experiments at our Kewalo Research Facility.

The following provides a summary of the highlights of our research efforts:

1. Stock assessment

a. The Honolulu Laboratory in 1977 organized a workshop to review the status of knowledge on billfish biology and stock assessment. The results of the workshop were published in a paper entitled, "Billfish Stock Assessment Workshop Pacific Resource" (NOAA-TM-NMFS-SWFC-5, July 1980).

b. The Honolulu Laboratory and the Far Seas Fisheries Research Laboratory of Japan organized and conducted a "Workshop on the Assessment of Selected Tunas and Billfish Stocks in the Pacific and Indian Oceans." The workshop was held at the Far Seas Laboratory in Shimizu, Japan, from 13-22 June 1979. The results of the workshop have been published in FAO Fisheries Technical Paper No. 200.

c. The Honolulu Laboratory is continuing tuna research directly related to problems identified in the tuna and billfish workshops.

2. Monitoring of tuna fisheries

a. The Honolulu Laboratory is presently revamping its data collection system in Hawaii and American Samoa. Efforts will also be made to collect tuna statistics from other areas in the Pacific.

b. The Honolulu Laboratory continues to provide the Western Pacific Regional Fishery Management Council with tuna and billfish data summaries and analyses for inclusion in the billfish FMP.

3. Biology

a. Conducted research on the influence of anchored rafts in aggregating tunas and other pelagic species in coastal waters of the central Pacific. The system utilized was patterned after the successful payao fishery developed in the Philippines. The success of the experiments in Hawaii has resulted in the development of a series of similar projects throughout the

Pacific, e.g., Western Samoa, Fiji, Cook Islands, Papua New Guinea, and eastern Pacific.

b. The Honolulu Laboratory succeeded in spawning tunas (Euthynnus affinis in 1979 and Katsuwonus pelamis in 1980) under laboratory conditions. It was discovered that the ovulation of captive skipjack tuna is induced by stress such as that associated with their capture. Thus no other artificial inducements such as hormonal injections are needed to force tunas to ovulate in shoreside tanks. Skipjack larvae were kept alive for a maximum duration of 12 days. Spawning and larval survival work will be continued this year.

c. Yellowfin tuna have been found to have concentrations of magnetite in the region of the brain. Laboratory experiments have also demonstrated that the yellowfin tuna is capable of responding to changes in the magnetic field, thus suggesting that this species and possibly other tunas and non-tuna species may be using the earth's magnetic field for migratory cues. Plans are being developed to initiate a major effort in this research endeavor.

THE SOUTH PACIFIC FORUM FISHERIES AGENCY- ITS ROLE IN THE CENTRAL AND WESTERN PACIFIC

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The South Pacific Forum Fisheries Agency (FFA) is an Agency of the South Pacific Forum, a political grouping of the South Pacific countries Australia, Cook Islands, Fiji, Kiribati, Nauru, New Zealand, Niue, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Western Samoa, and Vanuatu. The Agency, established in 1979, is based in Honiara, Solomon Islands. Its functions are to:

1. collect, analyze, evaluate and disseminate to its members statistical and biological information on the living marine resources of the South Pacific, in particular on the highly migratory species (HMS).

2. collect and disseminate information on management procedures, legislation, and fisheries agreements adopted by countries both within and outside the region.

3. collect and disseminate information on shipping, prices, processing and marketing of fish and fish products.

4. provide members with technical advice, information, and assistance in the development of fisheries policies and in fisheries negotiations, in licensing, in the collection of fees, and in matters of surveillance and enforcement.

5. establish working relations with relevant regional and international fisheries organizations.

The parties to the convention which established the Agency recognize that the coastal state has sovereign rights for the purposes of exploring, exploiting, conserving, and managing the living marine resources within its Exclusive Economic Zone (EEZ) which may extend 200 nautical miles from shore, and that effective cooperation for the conservation and optimum utilization of HMS of the Region requires some international machinery to facilitate cooperation between all coastal states in the Region and the distant water fishing nations (DWFNs) harvesting HMS in the Region.

The Agency consists of a Forum Fisheries Committee (FFC) and a secretariat. The membership is limited to the forum countries, and other states and territories in the region recommend by FFC and approved by the Forum. Agency meetings can also be attended by various observer states, e.g., Federated States of Micronesia, Marshall Islands, Palau, and organizations such as South Pacific Commission (SPC), South Pacific Bureau for Economic

Cooperation (SPEC), FAO, UNDP.

The Agency is financed by contributions from its members, with one-third of the total contributions coming from Australia, one-third from New Zealand, and the rest from the other members.

The FFC provides policy and administrative guidance and direction to the Agency, and a forum in which parties may consult on matters of common concern in fisheries.

The secretariat implements the Agency's work program. It is presently staffed by a director, deputy director, a legal officer, an economist, a statistician, a fisheries intelligence officer, and various adminstrative officers.

In May 1981, the Agency convened a Regional Research and Development Programme Meeting to:

1. review the state of knowledge of the HMS resources and identify areas of need for further resource data

2. review current exploitation of fisheries for HMS and identify the scope for and possible nature of further developments

3. review current utilization of fishery products and investigate future market and utilization trends

4. review institutional and business arrangements within the Region including access agreements, joint ventures, licensing, surveillance, and other arrangements

5. review national fisheries policies, objectives, and strategies for development

6. determine the scope for cooperation and coordination in research and dvelopment of fisheries for HMS in the Region

7. draw up a Regional Research and Development Programme which might be carried out by the fisheries organizations in the Region including FFA, SPC, and the various national research and development organizations.

The meeting resulted in a clearly defined listing of projects which could form the basis for a Regional Research and Development Programme for Fisheries for HMS in the Region. The projects were, in order of priority:

1. tuna and billfish stock assessment

2. harmonization of access agreements

3. investigation of Regional surveillance options

4. current fisheries information service

5. tuna fishing development
6. analysis of access agreements
7. development of coastal tuna fishing techniques
8. interactions among tuna fisheries in the western Pacific and South China Seas areas
9. technology of fish aggregation devices
10. identification of fishing patterns
11. effect of harvesting juvenile tunas
12. harmonization of fisheries legislation and reporting systems
13. investigation of regional enforcement options
14. baitfish population dynamics
15. economic analysis of tuna fishing
16. economic analysis of tuna marketing
17. fisheries training programmes
18. establishment of trial fishing operations
19. administrative training programmes
20. fishing vessel registration
21. economic analysis of tuna processing
22. delineation of fishing and related zones
23. baitfish culture
24. investigation of traditional fishing methods and conservation practices
25. investigation of fisheries support services
26. spawning grounds of coastal fishes
27. tuna industry experts register
28. port studies
29. development of solar powered refrigeration facilities
30. development of alternative energy systems

Some of the projects form part of existing or planned programs: of SPC, No. 1; of UNDP, No. 23; of FFA, Nos. 6 and 16; and of national research organizations, Nos. 3 and 13 recently carried out by New Zealand and Australia. Certain of the remaining projects which fall within FFA's mandate will be carried out by the Agency after consultations with SPC, other regional agencies, and with member countries, when the necessary staff and funding are available.

BAITFISH IN NEW CALEDONIA

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Since March 1980, a regular two-week fishing survey has been carried out around New-Caledonia to study the different species of bait used for pole and line tuna fishing.

The catches were made at night using a small "bouki-ami" net in sheltered bays. The fishes were attracted by a high-powered underwater lamp.

The best catches were made between February and March and the poor catches between September and November, the end of the winter season. The north and west coasts are the most productive, and the east coast the least.

The sardine, Herklotsichthys punctatus, the sardinella, Sardinella sirm, the sprats, Dussumeria acuta and Spratelloides spp., and several anchovy species, Stolephorus spp. and Thryssina baelama, are all excellent baitfish for the skipjack and the yellowfin tuna and are found in abundance, as are the inferior quality hardyhead, Pranesus pinguis. The proportions between the different species vary from one zone to another and from one survey to another, but sardines, sardinella and hardyheads dominate every catch.

The average size (total length) of baitfish is between 5 and 15 cm, the smallest being Spratelloides spp. and the largest being Sardinella sirm and Dussumeria acuta. Very few observations were made on the behaviour of these species in tanks or as actual bait. These baitfish appear to be more resistant in New Caledonia than in other regions of the tropical west Pacific particularly Papua-New Guinea.

This study has just begun; however, early results show the maximum baitfish season coinciding with the maximum tuna season and in areas where pole and line boats could stock up with enough baitfish to fish tuna around the New Caledonian coasts.

Table 1. Findings obtained in the four geographical zones of New Caledonia.

Zone	Catch/Haul						Catch/Night					
	Mar 1980	May '80	Jul '80	Sep '80	Nov '80	Feb '81	Mar '80	May '80	Jul '80	Sep '80	Nov '80	Feb '81
WEST	127	105	111	52	45	95	170	210	199	103	91	190
NORTH	197	153	171	47	7	128	296	203	284	78	13	193
EAST	39	31	14	15	3	70	71	63	25	29	4	139
SOUTH	130	156	23	35	15	147	261	311	45	70	23	295
TOTAL	112	88	81	36	19	102	183	163	144	69	34	191

A REVIEW ON THE EASTERN INDONESIAN SKIPJACK POLE AND LINE FISHERY

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The eastern waters of Indonesia, directly influenced by the Pacific, with scattered small islands distributed in areas like the Moluccas, Banda, and Flores-sea Island, is the main skipjack ground for this region. The 1978 total skipjack catch for this area amounted to 28,117 tons, of which about half was landed by pole and line fishing with live bait, while the other half was caught by inshore fishermen trolling. Since 1970, the government has been promoting the skipjack fishery development in East Indonesia through its state enterprises by increasing the number and size of skipjack boats and establishing better landing and storage facilities. These activities are not only for increasing skipjack exports but also to serve as stimulants toward improvement of all fishing activities in the vicinity of the state-owned skipjack companies.

The opinion of skipjack experts that the central western Pacific stock is not yet fully exploited can be supported. We must be aware of the danger we are confronting with the uncontrolled development of purse seining. We must be especially aware of the inshore or small scale fisherman, widely distributed in this region, who are expecting their traditional share in skipjack fishing.

A close cooperation in skipjack research, like subpopulation studies, should be considered.

RESOURCES OF SKIPJACK TUNA IN THE WESTERN PACIFIC

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INTRODUCTION

Markets and harvesting capability for skipjack tuna are more developed in the temperate regions such as in Japan, North America, and Europe, than in the tropical regions where skipjack has its major concentration. Consequently, until recently skipjack tuna have been harvested more in the peripheral regions of its distribution range and thus biological data on this species were limited to only some phases of its life history. Recent expansion of fishing activities towards the tropics is contributing to expanded catches and more information on the biology of this species. With this expansion the need for international exchange of data and views has become more important, especially because skipjack tuna is highly migratory in behavior, is economically important to many fishing nations that fish skipjack tuna on the high seas and in jurisdictional waters of foreign countries, and is traded in an international market. Accordingly, we believe it is useful to present, at this meeting, available information on skipjack tuna in the western Pacific.

MAJOR FISHING METHODS

The FAO statistics indicate that the world production of skipjack tuna ranged between 550,000 and 670,000 metric tons during the five years, 1974 to 1978. The Japanese fleet landed nearly half, 310,000 tons on the average, of the average world total of 640,000 tons during the five years. The northern and central western Pacific area is the most fertile fishing grounds for skipjack tuna, yielding 20 to 40 percent of the world total. Besides Japan, Indonesia, Papua New Guinea, Philippines and Solomon Islands harvest over 10,000 tons of skipjack tuna per year in the central western Pacific.

The Japanese skipjack fishery has long been conducted off the Japanese Islands by the pole-and-line method. In the mid-1960's development of improved techniques for maintaining live baitfishes for extended periods encouraged Japanese fishermen to construct large boats of 300 gross tonnages (G.T.) or larger for long-distance trips. These boats along with others greater than 70 G.T. constitute the Japanese distant-water baitboat fleet that expanded operations southward and eastward of the Japanese archipelago in pursuit of skipjack tuna for primarily canning. Their catch comprised over half of the national production of tuna until 1977. Another species caught by the distant-water baitboat fleet is albacore, also for canning, but is caught

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in summer and autumn off the north eastern part of Japan. The fishermen change their fishing strategy between skipjack and albacore depending on the profitability of each species (Asano, 1980).

The large vessels have been most seriously affected by rising fuel costs and wages, depressed demand in domestic and export markets, and limitations on fishing area access since 1977. The economic difficulties have been less for smaller offshore baitboats (20 to 70 G.T.) and for coastal boats (less than 20 G.T.). These boats supply the more stable domestic markets for fresh fish consumption.

In the major tuna areas such as the eastern Pacific and the eastern Atlantic, purse seiners have replaced the baitboats, which were dominant in the early years of the fishery. This coversion of fishing methods has not progressed rapidly in the western Pacific where the thermocline occurs as deep as 150 m below the sea surface and much deeper than in the eastern Pacific or eastern Atlantic. Fishermen are adopting the purse seining technique for catching tunas in the coastal waters along with "payaos" in some areas. Japanese purse seiners, on the other hand, operate in the open sea, mostly pursuing tuna schools associated with drifting logs. They have adopted very large nets of 1,400 m in length and 300 m in depth for this purpose. One-boat operation is fast replacing the two-boat operation that dominated the Japanese purse seine fleet until the 1960's. Two-boat operation consists of one seiner of 116 G.T., two carriers and one anchor boat. One-boat operation consists of a single seiner, mostly of 500 G.T.

Recent economic difficulties in the tuna fishery accelerated the conversion of baitboats to purse seiners. This conversion is intended to maintain an orderly market for tuna and to achieve rational utilization of the resources, but at the same time maintain, not exceed, the present level of total production of skipjack tuna by the Japanese fleet. The increased fishing effort by the newly built purse seiners is being offset by a decrease in fishing effort of baitboats as the number of operating baitboats is reduced.

MAJOR BIOLOGICAL FINDINGS

Available information on the distribution of skipjack tuna was reviewed by Kawasaki (1969), Klawe and Miyake (1967), Joseph and Calkins (1969), Miyake (1969), Ueyanagi (1972), Mori (1972), Tanaka (1974, 1975), Kearney (1978), Naganuma (1979), and others.

It is noted that the expansion of fishing activities has provided additional information on the occurrence of fish over 35 cm in body length, nearly 1 kg in body weight. But the information to date is still not sufficient for adequately describing the behavior of skipjack tuna during life stages not exploited by the fisheries and during the period when the species extends over the entire geographical range. Information to date show the following:

Skipjack tuna, along with other major species of Thunnus, are more widely and densely distributed in the western Pacific than in the eastern Pacific. The laravae are pelagic, distributed mostly in the layers above 70 m, and found in the tropical and temperate areas in 24°C to 28°C surface water temperature. Stomach contents of pradator species such as billfishes show that young skipjack of 15 cm and larger in body length are distributed over a wide range, extending into the higher latitudes as well as into the eastern Pacific.

Statistics of catch and effort of the Japanese baitboats of 20 G.T. and larger have been compiled and published for 10-day periods and one-degree square of latitude and longitude since 1972. Data on catch and catch rate are charted for 1972 to 1976, and they show seasonal migration of skipjack tuna. Fishing activity is concentrated in the equatorial waters in January to March. The fishing area expanded during this period, reaching southward to latitude 20°S and eastward to longitude 160°W in 1975. In 1976 it contracted. In April to June, fishing is in the waters south of Japan. It shifts northeastward in July to September, reaching latitude 44°N and longitude 164°W. In October to December, the baitboats pursue the migrating fish again into the equatorial waters (Kasahara 1978).

Examination of skipjack gonads indicates that spawning occurs in warm waters between latitude 35°N and latitude 24°S. It is found in the northwestern Pacific that the larger fish spawn earlier than the smaller fish, i.e., frequency of the spawners with high gonad index rises in October to March for 40-50 cm long fish, July to December for 50-60 cm long fish, July to September for 60-70 cm long fish and April to September for 70-80 cm long fish. In the southwestern Pacific, where the 40-60 cm group comprises the major spawners, the high gonad index is found in the southern summer of October to December (Naganuma 1979).

According to Tanaka (1980) and Tanaka and Yao (1980), there are significant variations in the size composition and the fishing seasons of skipjack tuna among the four major ocean current systems in the central and western Pacific. The size composition and fishing season by ocean currents in the western Pacific are summarized here in increasing order of fish modal length.

South Equatorial Current:	49cm to 53cm in December to April
North Equatorial Counter Current:	55cm to 59cm in June to November
North Equatorial Current:	61cm to 65cm and 72cm to 73cm in December to April
Subtropical Counter Current:	57cm to 59cm, 68cm to 70cm, and 72cm to 75cm to June to November

The major length group is taken first in the two southern current systems, then in the northern system, where fish of modal length 61 cm to 65 cm in the north Equatorial Current and 68 cm to 70 cm in the Subtropical Counter Current are caught.

Yao (unpublished) analyzed length composition data of Kawasaki (1955a,b), together with additional material. His results supplement extensive information on growth from tagging and related data collected on surveys conducted by the South Pacific Commission in the equatorial and southwestern

Pacific. It is noted that among fish from the waters adjacent to Japan, increments of body length of major groups of medium-sized fish is significantly larger in the northern fishing area than in the southern fishing area, thus making it difficult to develop a single growth curve. Yao proposed two explanations for the apparent geographical variation of growth. One is that growth is retarded due to sexual maturation of the fish in the southern grounds. If this is true, then the shift of modal size based on all the data represents the average growth of skipjack tuna from the western Pacific. Alternatively, the variation could be attributed to changes in school composition in the southern grounds during their northward migration off Japan. Usually the large-sized fish precede the smaller members of the same group in the course of their migration. Thus the size composition in the southern grounds may represent the largest members of the group at the beginning of the fishing season but the smaller members towards the end of the season. Such changes in school composition in the southern grounds during the fishing season result in underestimation of growth. Under this condition it is reasonable to estimate the growth rate based on data from only the northern area where the school compositions do not change significantly.

Regressions of the modal length for 10-day periods of a year were computed for three size groups: a small-sized minor group, a medium-sized dominant group, a large-sized minor group, and all groups were combined for the period from late August through late October. The von Bertalanffy growth equation was also fitted to the data. The results appear reasonable with the assumption that data from the northern area are representative for the population. The growth curve agrees fairly well with recent estimates for skipjack tuna from other parts of the Pacific Ocean (Figure 2). But this estimate has the limitation that, because it is derived from data taken from a limited area within the larger distributional range of the species, it may not necessarily represent the growth for the entire population. Recent findings (Fujino 1980) on the genetic segregation between the eastern and western stocks in the Japanese waters were also not taken into consideration. Our plans are to analyze data obtained during the last 30 years and include these factors and others in the analysis.

STOCK ASSESSMENT AND FISHERY MANAGEMENT

The pre-season forecast of fishing condition has long been one of the major research activities of the Tohoku Regional Fisheries Research Laboratory. However, the stock size has not been predicted well in advance of the fishing seasons because it comprises primarily only a single age group, two-year-olds. Only information on the catch in the southwestern Japan has been used for the forecast analyses. Further research is required to confirm the possibility of tracing year-class strength (Tanaka 1980; Tanaka and Yao 1980) over the entire distribution ranges of the population.

Kasahara (1978) showed that the catch-per-unit-effort has not declined in spite of recent increases in fishing effort. Other major skipjack fisheries also fail to show any significant correlation between CPUE and amount of fishing effort. This is considered evidence that skipjack tuna stocks in the Pacific are not yet fully exploited even though the current catch exceeds 500,000 tons, the lowest limit of potential yield estimate for the stocks in the early 1970's (Gulland 1970). Kearney (1978) discussed several biological

reasons for the stocks currently being underexploited.

Besides biological limitations, economic factors could affect further development of the skipjack tuna fishery. The sudden increase in skipjack catch during late 1977 through early 1978 resulted in a sharp decline in price of fish, which discouraged fishing for this species in both the tropical and temperate areas. This event emphasizes the strong current influence of economic factors rather than biological factors in skipjack fisheries.

SEA SURFACE SALINITY AND JAPANESE POLE AND LINE SKIPJACK FISHERIES IN WESTERN TROPICAL PACIFIC OCEAN

William Bour

Office de la Recherche Scientifique et Technique Outre-Mer
Noumea (New Caledonia)

Since October 1975, monthly sea surface salinity charts, of the western tropical Pacific Ocean, are performed by ORSTOM laboratory in Noumea. The $35^{o}/oo$ isohaline can be considered as the western limit of the equatorial upwelling. Inside the area of the upwelling, the salinity is higher than $35^{o}/oo$ and decreases fairly rapidly outside.

The tradewinds blowing along the Equator from the east induce the equatorial upwelling because of the divergence of the northern and southern parts of these winds. More rich and saline waters are then spread on the surface. The upwelling waters create, in contact with warmer waters of lower salinity, a convergence situated roughly at $5^{o}N$ and $10^{o}S$ latitude. This convergence is well marked by the $35^{o}/oo$ isohaline. Sometimes, the trade winds are weak and the winds blow from west; then is no more upwelling along the equator. The western winds carry much rain, so, low salinity waters spread to the east. The contact with the high salinity waters coming from the central Pacific create a doming along the $10^{o}S$ latitude; this new convergence is also well limited by the $35^{o}/oo$ isohaline.

The comparison of the extension of the Japanese pole and line skipjack fisheries with the situation of the equatorial upwelling was carried out, on a monthly basis, from October 1975 to December 1978. Generally, when the equatorial upwelling is well developed (extension $150^{o}E$), the Japanese pole and line fleet seems to be active and profitable outside of the equatorial upwelling and especially along the convergence drawn by the $35^{o}/oo$. If the equatorial upwelling disappears, the fishery seems to spread more southward (to a certain extent because of difficulties in getting baitfish) along the southern convergence.

One reason for this spread could be that the surface enrichment provided by the equatorial upwelling initiates a food chain leading to the higher levels (i.e. tunas) along the convergence. In fact, more zooplankton concentration is observed in the equatorial upwelling than outside. Usually the upwelling is strong from August to December, then decreases to a minimum in March. Sometimes, the western winds continue all the year long, maintaining low salinity along the equator. This situation occurred in 1976 and a convergence appeared along the equator providing good catches for the fleet. Nevertheless in this situation, the boundary marked by the $35^{o}/oo$ is less expressive than when the equatorial upwelling is well developed.

Three figures are chosen for this summary to depict the phenomenon. (Note: in order to take account of the delay between one hydrological situation and the biological response of the tunas, the $35^{o}/oo$ isohaline was drawn up with the fishing situation of the following month). (Arrows indicate

the winds).

Figure 1. Catches from November 1975, isohalines from October 1975. The equatorial upwelling is in full extension: the main catches seem to be performed along the northern 35°/oo isohaline. Some fishing occurred inside the upwelling but less successfully.

Figure 2. Catches from February 1977, isohalines from January 1977. Much rain, from the west pushes low salinity waters towards 170°E but northeastern winds permit high salinity waters to occupy the equatorial area east of 170°E. The fishery takes one of its greatest extensions, southward.

Figure 3. Catches from November 1978, isohalines from October 1978. The equatorial upwelling has just recovered its full extension but is still weak; good catches take place along the 35°/oo isohaline but also inside the area. This figure shows that the 35°/oo-fishing relationship is much less evident when equatorial upwelling is not well established.

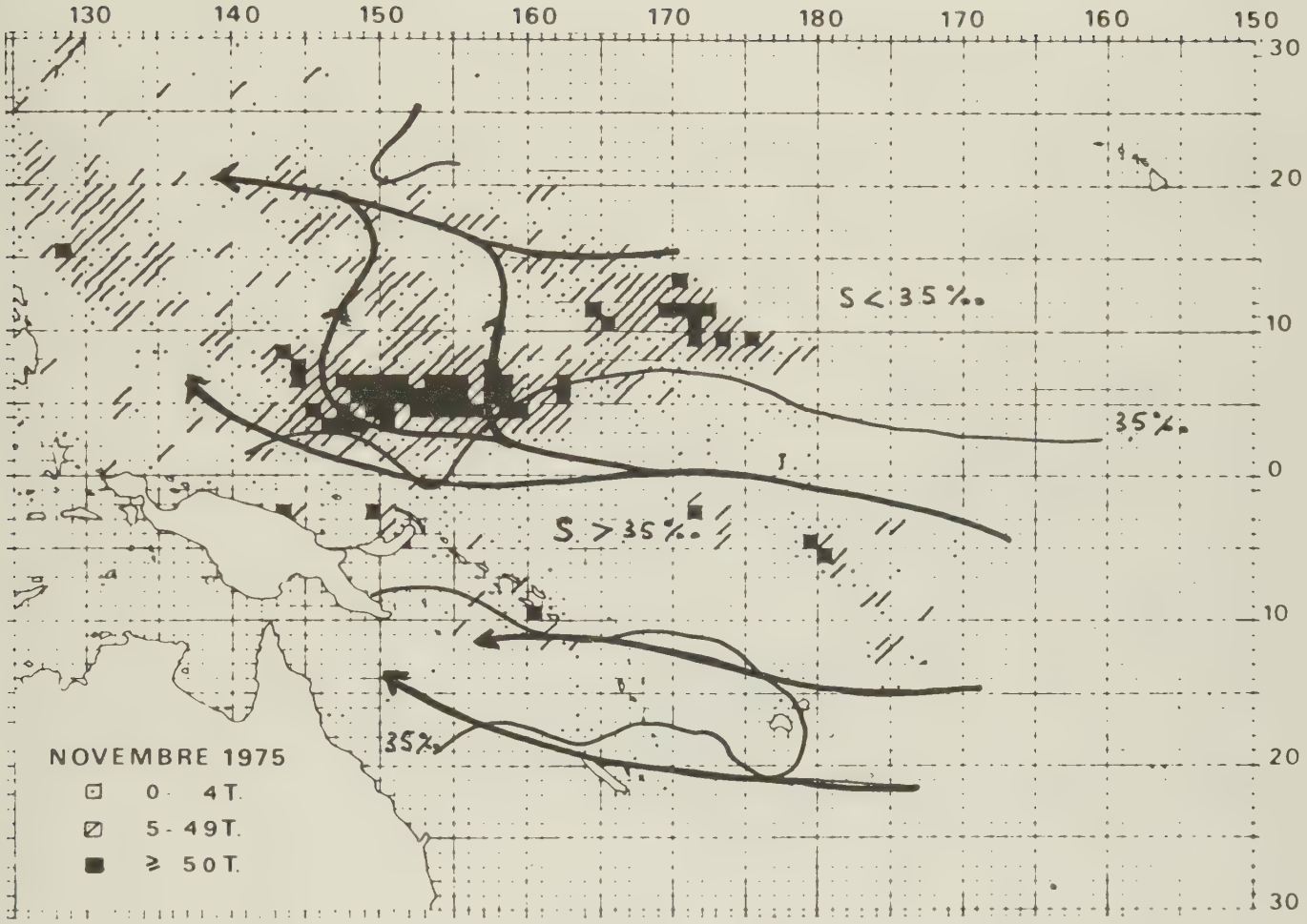

Figure 1. Catches from November 1975, isohalines from October 1975. The Equatorial Upwelling is in full extension : the main catches seem to be performed along the northern $35^{0}/_{00}$ isohaline. Some fishing occured inside the upwelling but less successfully.

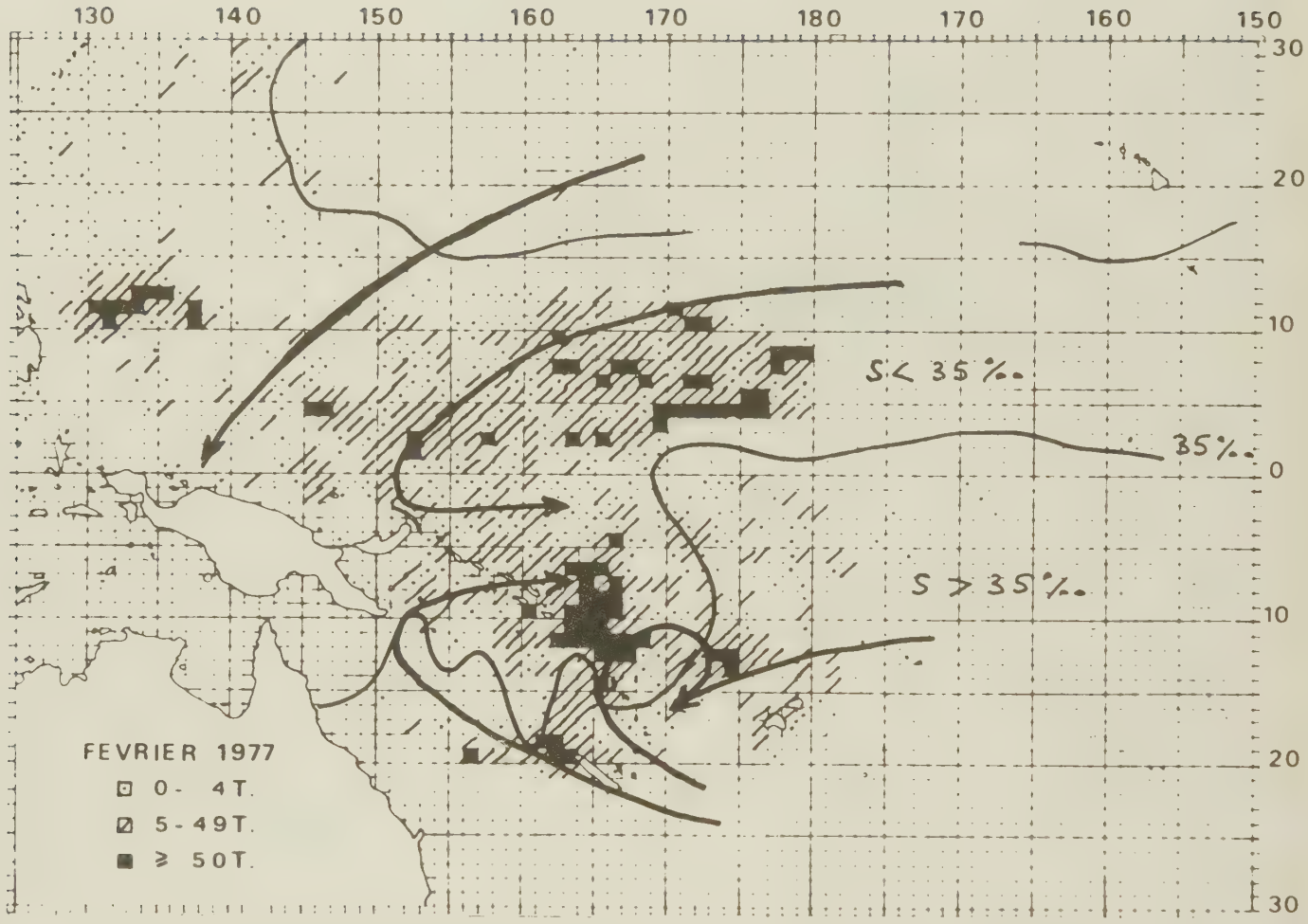

Figure 2. Catches from February 1977, isohalines from January 1977. Much rain, from the West, pushes low salinity waters towards 17°E but North Eastern winds permit high salinity waters to occupy the Equatorial area, east of 170°E. The fishery takes one of its greatest extensions, southward.

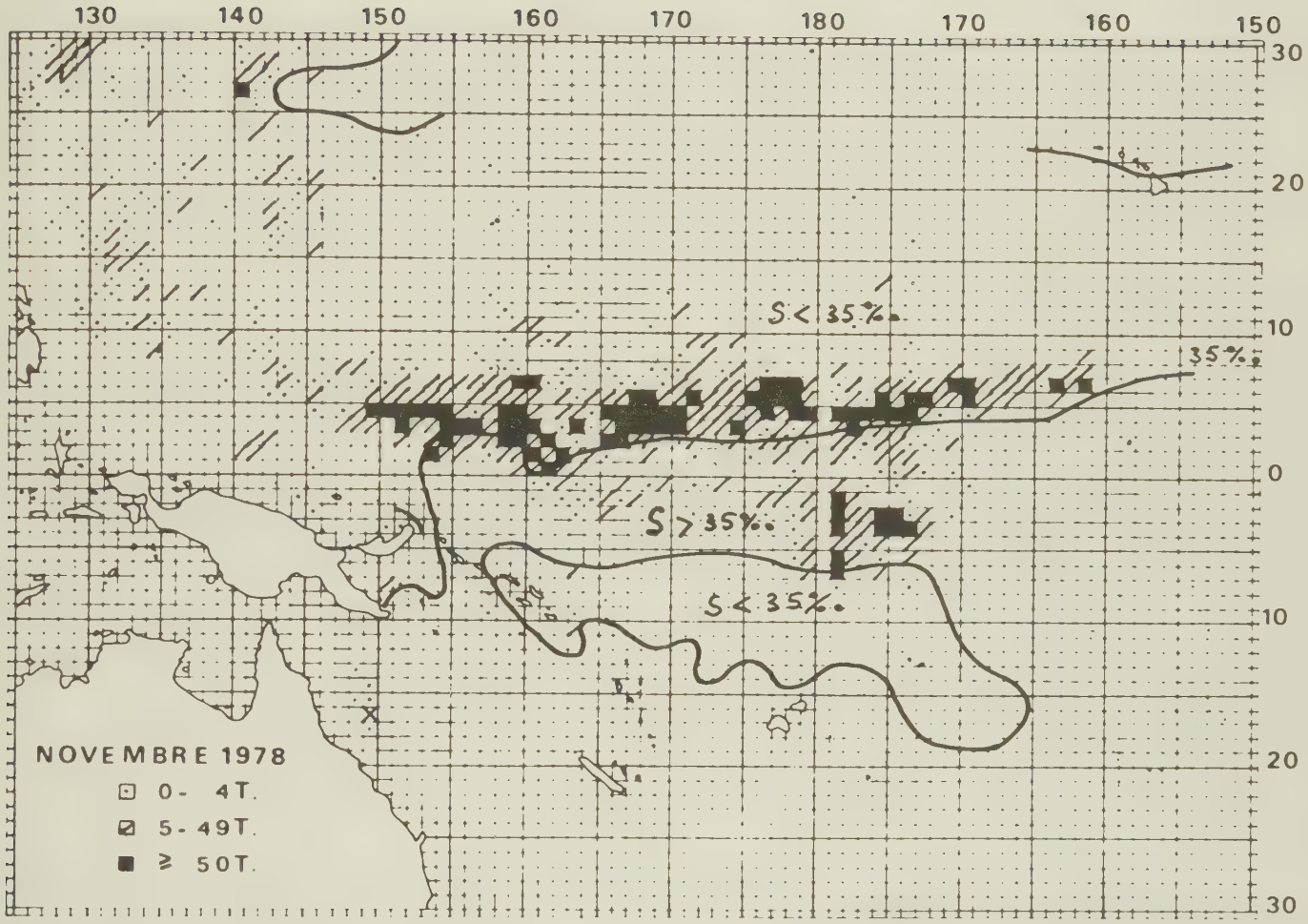

Figure 3. Catches from November 1978, isohalines from October 1978. The Equatorial Upwelling has just recovered its full extension but is still weak; good catches take place along $35^{0}/_{00}$ but also inside the area. This figure shows that the $35^{0}/_{00}$ - fishing relationship is much less evident when the Equatorial Upwelling is not well established.

SUBPOPULATION STUDIES OF TUNAS

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The results of the 1979 pilot study on yellowfin tuna stocks indicate that trace element analysis of dorsal spines, using x-ray spectroscopy, yield characteristic patterns. These patterns can be used to distinguish southern range from northern range juvenile yellowfin. Dorsal spines from 25 fish sample were irradiated. These samples were taken from 5 boats off Mexico and from 5 boats off Costa Rica during a nine month period. Individual spectra were compared using multivariate statistics and Monte Carlo randomization techniques. The results demonstrated characteristic differences in the chemistry of juvenile yellowfin spines. Such differences may persist and form the basis of a "natural tag."

A new system to conduct trace element chemistry on small spine and vertebrae cross-sections is now operational at California Institute of Technology, Pasadena. Developed at Princeton University, the system, "P.I.X.E.," uses a proton beam generated by a "particle accelerator" or "cyclotron." The beam, when directed at a sample, produces x-rays that provide a form of "chemical fingerprint." The automated system provides chemical spectra in less than 5 minutes and stores data on magnetic tapes.

Other studies of giant bluefin in the Mediterranean Ocean and Atlantic Ocean near the Gulf of Mexico suggest that stocks may mingle. Samples of age-0 fish have been collected from both oceans. The objective of our present program is to determine the rate of admixture using related trace element chemical analysis. In order to determine the rate of admixture, if any, the vertebrae of age-0 fish from both areas, and of adults from the western Atlantic, are being analyzed.

An extensive sampling program of juvenile yellowfin tuna is now underway in the eastern tropical Pacific. Sampling is expected to continue for several years. Cohorts will be followed in time. Differences and similarities in x-ray patterns are expected to yield data on movement and admixture.

ESTIMATION OF THE TOTAL NUMBER OF PURSE SEINE SETS ON TUNA ASSOCIATED WITH DOLPHINS IN THE EASTERN TROPICAL PACIFIC FOR THE YEARS 1959-1980

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The annual numbers of purse seine sets on tuna associated with dolphins in the eastern tropical Pacific are estimated from IATTC logbook abstracts and landing data. Methods are developed for the estimation of the number of dolphin sets from logbook records in which the set type and/or the number of sets was not recorded. Estimates are based on the set types of nearest neighbor sets, the annual proportions of sets associated with dolphins, and the magnitude and species compositions of tuna catches. The estimated totals are adjusted for trips not covered by the logbook abstracts. The total numbers of dolphin sets are estimated for the years 1959-1980.

PURSE SEINER SEARCH PATTERNS IN THE EASTERN PACIFIC

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The purse seine fleet in the eastern tropical Pacific, being a commercial fishing fleet, has been assumed to search in a non-random manner for tuna. This non-random element has often been assumed to affect searching for dolphin schools, thus rendering the calculation of density estimates of dolphins from data collected aboard tuna boats a futile exercise. It is possible to identify two sources of non-randomness in purse seine search patterns. Firstly, vessels tend to choose general areas in which to concentrate their fishing effort. This choice may be determined by time of year, the relative availability of large yellowfin associated with dolphins, the availability of skipjack, the fishing captain's experience and preference, weather conditions, location of code groups, etc. Secondly, once vessels are in a general area, they may search in a non-random manner, responding to areas of high tuna and/or dolphin density by spending proportionally more time there.

Large scale non-randomness may be partially accounted for by delineating areas where fishing is primarily for tuna associated with dolphins (generally offshore areas) and areas where fishing is primarily for free swimming tuna or tuna associated with floating objects (generally inshore areas). This has been done using IATTC data for 5^{o} x 5^{o} "squares" on an annual basis for the years 1974-1979. Some 5^{o} x 5^{o} "squares" change type from year to year; others remain the same. Pooling data from 1970-1979 shows which 5^{o} x 5^{o} "squares" consistently support the same predominant fishing modes.

It is possible to test for large scale non-randomness by assuming a relationship between search effort and sighting success, and by testing for results which depart significantly from those expected if searching were at random. This has been done for annual data for spotted and spinner dolphins stratified by 5^{o} x 5^{o} "squares". Sighting success was measured in two ways: firstly, by the number of sightings, and secondly, by the number of sightings corrected for sighting conditions. Results show that there is little evidence of a non-random response to areas of high sighting rate or density of dolphins even within areas where fishing for tuna associated with dolphins predominates. There are several possible explanations for these somewhat surprising results. Firstly, areas of high dolphin density may not necessarily be the areas of high tuna availability. Secondly, searching may be non-random but increased set time in areas of high dolphin density reduces search time. Thirdly, searching is potentially non-random but areas of high density change faster than the fleet can keep up with. Fourthly, searching within a 5^{o} x 5^{o} "square" may not be at random.

To investigate this final possibility, a similar test to the above has been performed using 1^{o} x 1^{o} "squares" within some of the previously defined 5^{o} x 5^{o} "squares". Data were for spotted dolphin schools sighted in 1977,

using the number of sightings as a measure of sighting success. Once again, there is little evidence of non-random searching behavior in response to areas of high dolphin sighting rate.

THE USE OF ANCHORED RAFTS TO AGGREGATE TUNAS

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A number of fisheries take advantage of the association of fishes with floating objects, two of the most familiar being pole-and-line and purse seine fishing for tunas found in association with logs, debris, and other flotsam. The hypotheses advanced to explain this association include: 1) attraction by food, 2) seeking of shade under the object, 3) seeking shelter from predators, 4) use of the object as a spawning substrate, 5) the object functions as a cleaning station, and 6) the object provides a visual stimulus in an optical void (Hunter and Mitchell 1966).

Local fishermen in areas such as Japan, Indonesia, the Philippines, and Malta have used moored objects such as bamboo rafts, palm frond rafts, and cork slabs for many years to attract various fishes. Fishermen in the Philippines have also demonstrated that tunas can be attracted to anchored rafts in numbers large enough to successfully support commercial purse seining operations (Murdy 1980).

In the past several years a number of projects have been initiated, mostly in the central and western Pacific Ocean, to test anchored fish aggregating devices as a means to increase fish production, especially skipjack tuna. These projects are especially of value around island areas where local fishermen operating small, short-range boats seldom encounter logs, and if they do, can utilize them only for the short time the logs remain drifting in local waters. Results from these projects have been mostly good, as has fisherman response. A problem common to many of these projects has been the short longevity of the rafts. Some of the projects are being extended using new raft designs and anchor systems.

Purse seining in the eastern Pacific for tunas associated with floating objects for the period 1978-1980 has provided a larger proportion of the total yellowfin and sipjack catch than either schoolfish sets or sets made on tunas associated with dolphins. Floating object sets have also yielded a higher catch per set.

The IATTC constructed and deployed five anchored rafts in the eastern tropical Pacific Ocean during the fall of 1980. The objective was to test their effectiveness in attracting and aggregating tunas, especially yellowfin of the size normally found in association with dolphin schools. Such anchored devices might possibly provide a visible alternative fishing method to fishing for tunas associated with dolphins, thereby reducing fishing effort for tunas associated with dolphins possibly resulting in lower dolphin mortality. The rafts were deployed in areas where both dolphin sets and floating object sets are made, and more than 200 miles from the mainland coast and any islands.

The international purse seine fleet operating in the eastern Pacific Ocean was notified of the rafts' positions and was asked to provide the IATTC any information concerning the rafts.

As of this meeting, three of the rafts are known to be lost. Only three purse seine sets are known to have been made on tunas associated with the rafts while they were anchored, resulting in a total catch of approximately 21 tons of skipjack and yellowfin tuna. There have been additional catches on one of the rafts after it broke free from its mooring. Causes of the raft losses are not known. All yellowfin caught have been small fish, not of the larger size normally found in association with dolphins further testing is needed to determine if anchored rafts or similar devices are feasible in the tuna purse seine fishery in the eastern Pacific Ocean.

Free-drifting man-made fish aggregating devices may be an alternative to anchored rafts. Free-drifting data buoys in the eastern Pacific are known to attract tunas and have yielded some very large purse seine catches.

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THE USE OF SATELLITE REMOTE SENSING FOR THE IDENTIFICATION OF OCEAN FRONTS AND ITS APPLICATION TO ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS THYNNUS) UTILIZATION AND MANAGEMENT

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The principal objective of this program, supported by the National Aeronautics and Space Administration (NASA), is to contribute to fisheries forecasting, utilization, and management by use of satellite remote sensing (e.g. NIMBUS - Coastal Zone Color Scanner; NOAA-TIROS - infrared, visible; GOES - ir., vis.). This task is being accomplished by integrating multispectral with infrared and visible remotely-sensed data for the identification and study of such environmental dynamics as circulation, frontal history, and ocean productivity. These ocean conditions are being correlated with distribution, movements, availability, catch, and spawning success of bluefin tuna in North Carolina and Virginia coastal waters, and in the Gulf of Mexico. Similar fisheries data are also being analyzed for other species including skipjack tuna (Katsuwonus pelamis), bluefin (Pomatomus saltrix), and the sand lance (Ammodytes americanus). Derived apparent relationships between environmental and fisheries variables are being cross-correlated with forcing mechanisms, such as insolation, winds, surface transport, upwelling, mixing, etc. Appropriate satellite imagery data tapes are being processed using the University of Miami's interactive computerized displays system (black and white and color enhancement).

Priority has been given to data analyses related to the "onset", daily changes in distribution and availability, and "end" of the rod and reel and purse seine fisheries in North Carolina, Virginia coastal waters. "Onset" of the fishing season appears to be related to formation of the surface mixed layer during spring warming and water column stratification. Arrival of the bluefin tuna (and end of the season) appears to be related to a surface mixed layer of approximately four meters (eight to ten meters) with sea surface temperatures of 19.0 C (24.0-26.0 C) and 17.5 C (24.0 C) at the top of the thermocline. Daily movements during the season appear to be related to changes in concentrations of forage (sand eels), which appear to be mediated by Chesapeake Bay plume frontal history and productivity.

Analyses related to daily and weekly changes in the Japanese longline fishery for bluefin tuna have shown that effort and catches have not been concentrated in areas of maximum sea surface temperature gradients (i.e. the Loop Current) in the Gulf of Mexico. In addition to bluefin tuna, all tunas, billfishes, and sharks that are caught on the longlines with bluefin are being considered in the analyses.

EXPLORATORY ALBACORE LONGLINING OPERATION CONDUCTED IN MID-WINTER, 1981

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Three chartered commercial fishing vessels using modified halibut longlining gear conducted an exploratory albacore longlining operation 700 to 900 n miles west of San Diego during January-February 1981. The objective of this investigation was to evaluate the potential for establishing a U.S. fishery on the southern substock of North Pacific albacore tuna during winter months in eastern North Pacific waters. The U.S. albacore fishery currently does not operate in the winter, and in the selected area limited exploratory troll fishing has taken place only during other seasons of the year. Among the purposes of the study were to (1) conduct exploratory fishing using trolling and longline fishing methods to evaluate the feasibility of catching albacore; (2) make scientific observations to determine oceanographic conditions that may influence albacore distribution and relative abundance; and (3) collect data for albacore biology and fishery studies.

This cooperative study was carried out by the NMFS Southwest Fisheries Center and the U.S. albacore fishing industry's American Fishermen's Research Foundation (AFRF). Saltonstall-Kennedy funds awarded to the AFRF were used to charter fishing vessels and finance other costs to conduct the study. Fishery scientists at the Center planned the overall project and worked with the AFRF to organize the study. The actual operational aspects of the study were carried out by the AFRF. The SWFC provided scientific equipment and three Center scientists went aboard one of the chartered fishing vessels to make scientific observations and keep detailed records related to the fishing operations.

Results from this study suggest that the U.S. albacore fishery can be expanded to operate during the winter months. Within a large area 700 to 900 miles west of San Diego, albacore were caught each day during exploratory longline fishing operations. Logistic considerations limited the westward extent of this study; it is believed, however, that good fishing success may also be expected farther to the west, probably to at least the longitude of the Hawaiian Islands.

It appears that albacore production may average approximately 3,000 pounds per set using a longline with 1,500 to 2,000 hooks. This production estimate is based on an extrapolation of fish catches made using about 300 hooks. Experience gained during the study indicates that a 3-man crew can handle a 1,500 to 2,000 hook longline and that 50 to 75 foot vessels, typical of the U.S. albacore fleet, can operate in the latitudes of the area under study during winter months. More exploratory effort is needed in trolling to arrive at conclusions regarding potential yields. However, the catches made as a result of the small effort expended during this study were encouraging.

VULNERABILITY OF YELLOWFIN TUNA TO PURSE SEINING IN RELATION TO VERTICAL TEMPERATURE STRUCTURE IN THE EASTERN PACIFIC

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During the 1970's the Inter-American Tropical Tuna Commission and the Southwest Fisheries Center, in a cooperative program, collected and analyzed many hundreds of expendable bathythermograph (XBT) and surface observations taken aboard tuna boats in the eastern tropical Pacific. Vertical temperature profiles from XBT traces were related to catches of yellowfin in schools and yellowfin associated with porpoise. From studies beginning in 1973, a hypothesis evolved that yellowfin in schools without porpoise may be more vulnerable to purse seining when the 23°C and 15°C isotherms are close to the sea surface. Some physiological studies have indicated that 23°C is a central temperature of a favorable yellowfin habitat, and 15°C represents a lower limit that tunas can withstand for sustained periods. This hypothesis is based on the postulate that when the lead line of a 73 m (240 ft) or smaller purse seine net is located below the bottom of a sharp thermocline, the fish usually will not attempt to escape from under the net because of cold temperatures and low levels of oxygen.

In the eastern tropical Pacific, temperatures in the upper part of the mixed layer are nearly always greater than 23°C in areas where yellowfin are captured, and in the easternmost part of the area the 23°C isotherm lies most frequently in the upper third of the thermocline (subsurface zone where temperatures decrease rapidly). The 15°C isotherm is usually near the bottom of the thermocline where temperatures begin to change slowly with depth. Changes in depths of the 23°C and 15°C isotherms reflect both the depth and the strength of the thermocline. The vertical distance between these two temperature surfaces is inversely proportional to the thermocline strength.

Statistical analysis using the 1971-1975 data supported the above hypothesis. However, during the 1970's there were several non-environmental factors which frequently influenced fishing effort and made the interpretation of the results inconclusive. During 1979 and 1980 six additional years (1970 and 1976-1980) of thermal XBT profile data were analyzed to form an 11-year data base (1970-1980) which was compared with catch and effort data for corresponding periods. Recently the Commission staff decided to apply statistical methods to this study which would provide more definitive results regarding the relationship between catch rates and distribution of the 23°C and 15°C isotherms within more specific strata of space and time. In this study fishing success was based on yellowfin catch (tons) per hour of search time within the CYRA during the nonregulated period from January through June. Three categories of catch rates were selected to reflect low, medium, and high catches of yellowfin per hour of search time.

Three categories of 23°C isotherm depths were selected on the basis of earlier studies which related school fish catches (tons) to depths of the mixed layer and depths of the 23°C isotherm. The 23°C isotherm was a good discriminator for small and large catches and a poor discriminator for medium size catch rates. The statistical analyses of 11 years also tended to confirm the hypothesis that non-porpoise associated fish may have been vulnerable to purse seining when the net hung in or below the thermocline.

The observed frequencies comparing catch versus temperature reflect a high degree of association between: 1) high catch rates and shallow 23°C isotherm depth, 2) low catch rates and deep 23°C isotherm, and 3) the opposite classifications to 1) and 2). The observed frequencies in the middle row of the classification contributed least to the chi-square test of association. However, the chi-square value ($X^2 = 157$) is highly significant ($p<001$) and supports a strong association between yellowfin school fish catch rates and depths of the 23°C isotherms.

The relationship between thermal structure and catch-per-hour of search has been statistically significant and consistent, and these results have indicated that there is an application of vertical temperature structure in defining those areas within the CYRA where good catches of small yellowfin school fish could be expected based on the vertical temperature structure. Before attempting to utilize such data to adjust indicies of abundance, additional research of this type relating thermal structure to catch rates of porpoise-associated fish and skipjack is being completed.

WESTERN ATLANTIC SKIPJACK TUNA (KATSUWONUS PELAMIS), EVALUATION OF AVAILABLE FISHERY AND BIOLOGICAL DATA

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SUMMARY

Available fishery and biological data on western Atlantic skipjack tuna were reviewed in order to formulate working hypotheses on stock structure that might aid in the International Skipjack Year Program research. The literature was reviewed and research cruise data were examined for pertinent information on skipjack tuna in the western Atlantic, Caribbean, and Gulf of Mexico. Length-frequency, and spatial-temporal distribution of catches were analyzed and the results evaluated. Available data were found to be sparse. Stock structure evidence for a single Atlantic-wide or east-west stocks was presented.

Skipjack distributions in the Atlantic seem to follow generally the same pattern as observed in the Pacific, with the exception of the Gulf of Mexico and Caribbean basins. Supporting data indicate that larval concentrations appear in the northwest between 0^{o} and 20^{o}N although spawning occurs year-round throughout the equatorial Atlantic as in the Pacific. Juvenile and young skipjack tuna appear to be more widely distributed in cooler waters and in higher latitudes than skipjack larvae. Young adult skipjack are first found in the Caribbean in warm surface water and in the Atlantic in the cooler surface water. Longline data indicate that adult skipjack occur in the higher latitudes in the second semester of the year. Data from the Cuban baitboat fishery indicate adult skipjack occur in the Caribbean Sea-Gulf of Mexico basin year-round.

STUDIES OF SIZE COMPOSITION, BY AREA, OF YELLOWFIN TUNA IN THE EASTERN PACIFIC

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From the establishment of the sampling measurement areas of the Tuna Commission in 1957 to date, many changes in the geographical distribution of the catch of yellowfin tunas have occurred due mainly to changes on the vessel composition of the tuna fleet in the eastern Pacific. The proportion of baitboats and purse-seiners in the eastern Pacific changed progressively since 1955 when baitboats were the dominant group. By 1980, the proportion reached 80% purse-seiners and a 20% combination of baitboats and small tuna boats. The geographical expansion of the yellowfin catch in 1979 and 1980 within the CYRA was between about 33°N and 12°S; and outside the CYRA it was extended westward but not past 150° West.

A list of factors that modify species distribution and size relationship of tunas in the eastern Pacific was described. Also, a comparative analysis of results obtained in previous studies was described.

Based on the above background, in the present study length-frequency data of yellowfin was processed by computer analysis to assign each sample 1° and 5° square areas within the CYRA. (The statistical areas of the CYRA were shown).

Data from 1976 to 1978 were categorized into four dominant size groups. Analysis of the geographical distribution of these size groups was conducted in order to develop sampling strata which are more homogeneous with respect to fish sizes in the catch and to identify areas of special interest. As a result seven roughly defined areas were obtained. (The 1976 map with the dominant size groups by 1° square areas was shown).

By comparing the 3 years of results, it was found that the dominant size groups differ in size categories within themselves. It was also observed that the shape of these areas is different and the spacial dynamic behavior of these areas may be visualized.

To demonstrate the validity of the shape of these preliminary areas it is necessary to have a comparative analysis of the length-frequency distributions by defining indices of comparison between them. To find those elements a theoretical multimodal function can be applied to each area to define its modal composition or mixture.

With certain experience in recognizing class groups of length-frequency histograms (from modal progressions), it is possible to sketch the component distributions and the theoretical multimodal function can be fitted by finding parameters values that make the discrepancy between the theoretical

distribution and the observed histogram as small as possible. However, the difficulty increases when the number of modes increase.

As a result, several characteristics of the length-frequency distributions can be defined as variables to be used as indices of comparison between areas during the process of defining strata limits.

The future of this project prevents the use of cluster analysis techniques which can be applied to the length-frequency indices in order to form groups with similar characteristics and differentiate area strata. Some of the new resulting areas will be expected to have different spacial distribution with respect to the preliminary areas. This stratification may be utilized in other biological studies in future research.

GROWTH OF SKIPJACK IN THE EASTERN PACIFIC OCEAN AS ESTIMATED FROM TAGGING DATA

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Most of the tunas which were tagged in the eastern Pacific Ocean prior to 1968 were measured to the nearest 5 cm, whereas during the 1968-1981 period they have been measured to the nearest 1 cm. Examination of data for fish measured to the nearest 5 cm and recaptured within 10 days after release indicates that the measurements of the length at release were biased, so these data were not used. No bias is evident for the fish which were measured to the nearest 1 cm at release. Significant differences in the growth rates of skipjack release west of 100°W in 1973, 1975, and 1976 and east of 100°W in 1979 were found. The following estimates of the parameters of the von Bertanlanffy growth equation were calculated:

Area	Sample size	Linear growth rate (mm/year)	K (annual)	L (mm)
west of 100°W	253	210	0.519	954
east of 100°W	134	323	0.999	842
combined	387	252	0.660	903

These estimates of the linear growth rate and L exceed those calculated for skipjack of Paua New Guinea, the Solomon Islands, and Fiji by other investigators, while the estimates of K for the eastern Pacific are less than those calculated for the southwestern Pacific.

A PROGRESS REPORT ON THE RELATION OF YELLOWFIN GROWTH TO OTOLITH INCREMENTS

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A previous mark-recapture experiment using tetracycline indicates that, in the fork length range of 40 to 100 cm, eastern Pacific yellowfin deposit one increment daily on their sagittal otoliths and grow at the rate of 3.06 cm/month. These rates involve increment counts only from the mark to the postrostrum of the otolith.

Estimates of absolute age require total counts from the primordium to the postrostrum. To prepare for this work, otoliths of approximately 15 fish in each 10 cm fork length category of the commercial range (30 to 170 cm) were etched and replicas made of the exposed increments. Criteria for identifying increments were established and random counts prepared for all fish in the 30 to 100 cm interval. Growth of six variables (fork length, predorsal and head lengths, weight, otolith weight, and distance from the primordium to the postrostrum) are described. Growth in fork length of 3.08 cm/month is apparently linear over the 30 to 110 cm range and compares favorably with the tetracycline results as well as previous estimates. Size-at-age for eastern Pacific yellowfin are 50 and 87 cm for the first and second years, respectively.

THE USE OF ALLELE FREQUENCY DATA IN FISHERIES MANAGEMENT

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Fisheries managers are spending increasing amounts of money on the acquisition of allele frequency data from fishes and other marine organisms. Much of this investment is in the form of small samples taken at random to the population structure of the species and is intended to illustrate the distribution of genetically isolated stocks. Such stocks provide fisheries managers with the genetically homogeneous populations that the continuous culture models used in fisheries management require.

The neutral theory of allelic variation provides theoretical support for the concept of genetically homogeneous and genetically isolated stocks of fish.

The neutral theory itself rests on five criteria. A critical examination shows that all five criteria are scientifically unacceptable. Consequently the distribution of allelic variant must be due to selection. The consequences of the selective central of allelic variation can be shown by two examples.

In the first of these, allelic variation at the transferrin locus is reviewed in terms of its physiology and biochemistry for vertebrates. Available information in the literature confirms the adaptive nature of allelic variants of this protein. The time-dependent variation that arises from the adaptive control over allelic variation seriously undermines the usefulness of allelic variants at this locus in stock discrimination. Other proteins, whose allelic biochemistries and physiologies are less well known than transferrin, nonetheless have been sufficiently investigated to strongly suggest that all allelic variants are under selective control.

The adaptive nature of allelic variation of the phosphyogluconutase locus in the tarakihi Checlodactylus macropterus is confirmed by the strong association between allelic phenotypes and the growth parameters of the von Bertalanffy curve.

Thus the significance of allelic variation to fisheries managers shifts from the pseudo-taxonomic issue of stocks to the physiological bases of productivity and recruitment.

*(Presently New Zealand Research Advisory Council fellow at the University of British Columbia.)

The material for this talk was drawn from a series of three papers that have been offered for publication to the Transactions of the American Fisheries Society. These papers are entitled:

Gauldie, R. W. and D. B. Jester. 1981. The influence of selection on the use of allele frequency data in fisheries management. I. The consequences for the management and modelling of fish populations.

Gauldie, R. W. and D. B. Jester. 1981. The influence of selection on the use of allele frequency data in fisheries management. II. Some problems associated with the use of variants at the transferrin locus.

Gauldie, R. W. and W. Gazey. 1981. The influence of selection on the use of allele frequency data in fisheries management. III. The association between growth curve parameters and allelic phenotypes of the phosphogluconuitase locus in the tarakihi (Checlodactyhus macropterus; Checlodactyhdae; Teleostei).

THE NEW ZEALAND TUNA FISHERIES

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The ten tuna and tuna-like species in New Zealand waters are skipjack (Katsuwonus pelamis), albacore (Thunnus alalunga), southern bluefin (T. maccoyi), bigeye (T. obesus), yellowfin (T. albacares), butterfly tuna (Gasterochisma melampus), frigate tuna (Auxis thazard), slender tuna (Allothunnus fallai), Australian bonito (Sarda australis), and blue mackerel (Scombet australasicus).

Commercial fisheries exist for skipjack (summer, purse-seine, catch 10,000 tons), albacore (summer, trolling and some pole and line, 2,000 tons; winter, longline 500-1000 tons), and southern bluefin (winter, longline, 5-10,000 tons; trolling, 1-200 tons).

Potential yields of skipjack are believed to be 20-25,000 tons, of albacore 10-20,000 tons, and of southern bluefin about present levels.

Research is being conducted on the species being taken in the commercial fisheries and on the fisheries for those species. Observers are used extensively on the commercial vessels, for the collection of fishery, biological, and hydrological data. Specific items of research are carried out from chartered vessels and by working in conjunction with international research programs. Emphasis is placed on the timely publication of data descriptive of the fisheries and resources. These data are also used each year as the basis for management decisions on the tuna fisheries.

THE INTERNATIONAL SKIPJACK YEAR PROGRAM OF THE ICCAT

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There is a general feeling among scientists involved in Atlantic tuna investigations that the Atlantic skipjack tuna stocks are not yet fully exploited and that the catch can be increased. Increases of as much as 250,000 tons or two times the present Atlantic catch have been mentioned as the potential increase available. Adequate information to plan the rational expansion of the fishery, however, is lacking so in 1978 the International Commission for the Conservation of Atlantic Tunas designed a research program to increase the information base on Atlantic skipjack tuna.

The program is for the period 1979 through 1982 and is divided into planning, execution and analysis phases. It relies on participating organizations, primarily the 19 ICCAT member countries, to provide most of the resources to execute the research activities while the ICCAT Secretariat provides coordinating services. The program plan consists of a set of nine activities (Figure 1), designed to answer four questions:

1. Can catches be increased by fishing new areas especially in the western Atlantic and new stocks?

2. Can catches be increased by fishing larger size groups (especially fish over 5 kgs) of currently exploited stocks?

3. What could be the effects of the increased fishing on new stocks or larger fish on the existing fisheries?

4. How can better assessments of the condition of the stocks be obtained with information from the existing fisheries?

In 1981 all of the activities are scheduled for execution. Major activity will be tagging and release of approximately 42,300 skipjack tuna in the eastern Atlantic and 5,500 skipjack tuna in the western Atlantic.

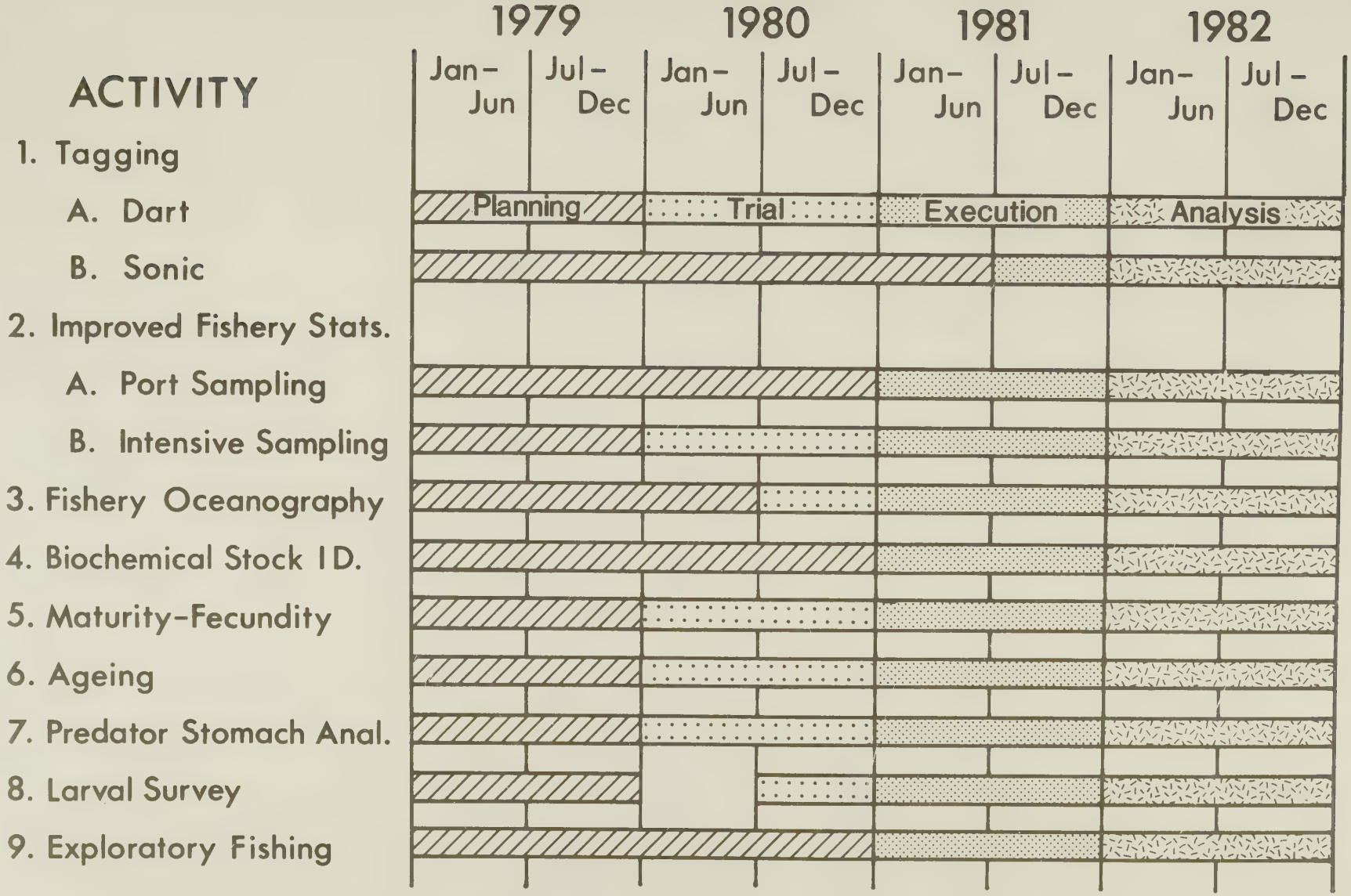

Figure 1. Schedule of research activities for the International Skipjack Year Program of the International Commission for the Conservation of Atlantic Tunas. Planning //////, execution ::::: and analysis ||||| phases are shown.

ATLANTIC YELLOWFIN TUNA MANAGEMENT ALTERNATIVES: POTENTIAL IMPACTS ON THE EASTERN TROPICAL ATLANTIC TUNA FISHERIES

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In 1973 the International Commission for the Conservation of Atlantic Tunas (ICCAT) imposed a minimum size regulation of 3.2 kg (or about 55 cm fork length) on Atlantic yellowfin tuna to discourage the development of fisheries on small fish, and thereby enhance the long-term Atlantic yellowfin yield.

Because of the relatively small increase in overall yield-per-recruit, and relatively large incidental catches of undersized yellowfin, since implementation of the minimum size regulation, ICCAT suggested in 1978 that alternative methods to deter fishing on small yellowfin be investigated.

Data from the Atlantic surface fishery (baitboat and purse seine), covering Atlantic yellowfin, bigeye, and skipjack catch, and yellowfin length-frequency, were used to estimate catches of total yellowfin, bigeye, and skipjack in the eastern tropical Atlantic from selected time/area/gear strata. These strata were then evaluated in terms of the small yellowfin protected, versus the total yellowfin, bigeye and skipjack catch foregone in order to identify candidate strata under a time/area/gear(s) closure management scheme. Preliminary results indicate relatively high purse seine and baitboat catches of small yellowfin from the Gulf of Guinea off the coasts of Ghana and the Ivory Coast during the early part of the year. However, unless the surface catches of large yellowfin, bigeye and skipjack foregone during a closure of this area to the surface fishery, later become available in adjoining areas or the same area, the losses from such a closure are likely to outweigh the benefits.

APPENDIX

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